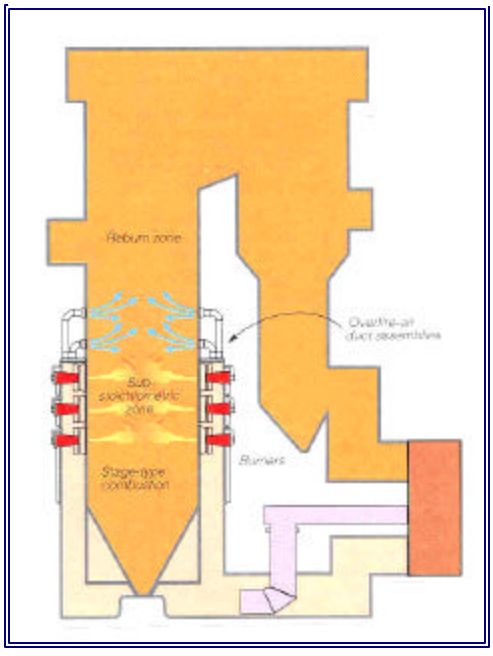
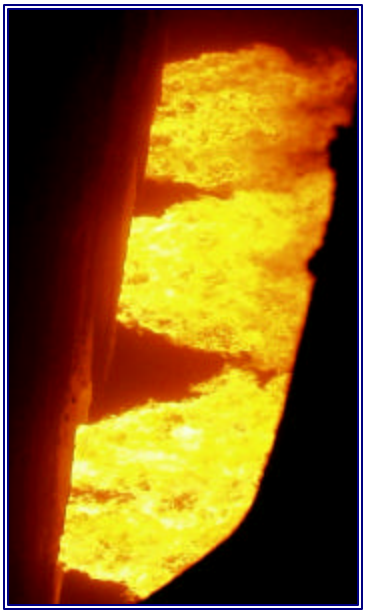
EQUIPMENT IN SERVICE

CINERGY GIBSON STATION FIVE (5) 650 MW CAPACITY UNITS ALL EQUIPPED WITH PHOENIX' S LOW-NOx BURNER SYSTEM.



SECTIONAL VIEW OF THE LOW-NOx BURNER SYSTEM

PHOENIX LOW-NOx BURNER IN SERVICE 285 MBTU PER BURNER



EQUIPMENT MANUFACTURE

COMPLETE EQUIPMENT OF LOW-NOx BURNER SYSTEM

LOW-NOX BURNER REAR-SIDE VIEW

LOW-NOx BURNER FRONT-SIDE VIEW

LOW-NOx BURNER EQUIPMENT ASSEMBLY

EQUIPMENT MANUFACTURE

O.F.A.& BURNER AIR REGISTER

BURNER EQUIPMEN

O.F.A. REGISTER

BURNER REGISTER SIDE VIEW

PHOENIX SYSTEMS INTERNATIONAL, INC.

TECH PROFILE
STATE OF THE ART
NEW
LOW-NOx TECHNOLOGY

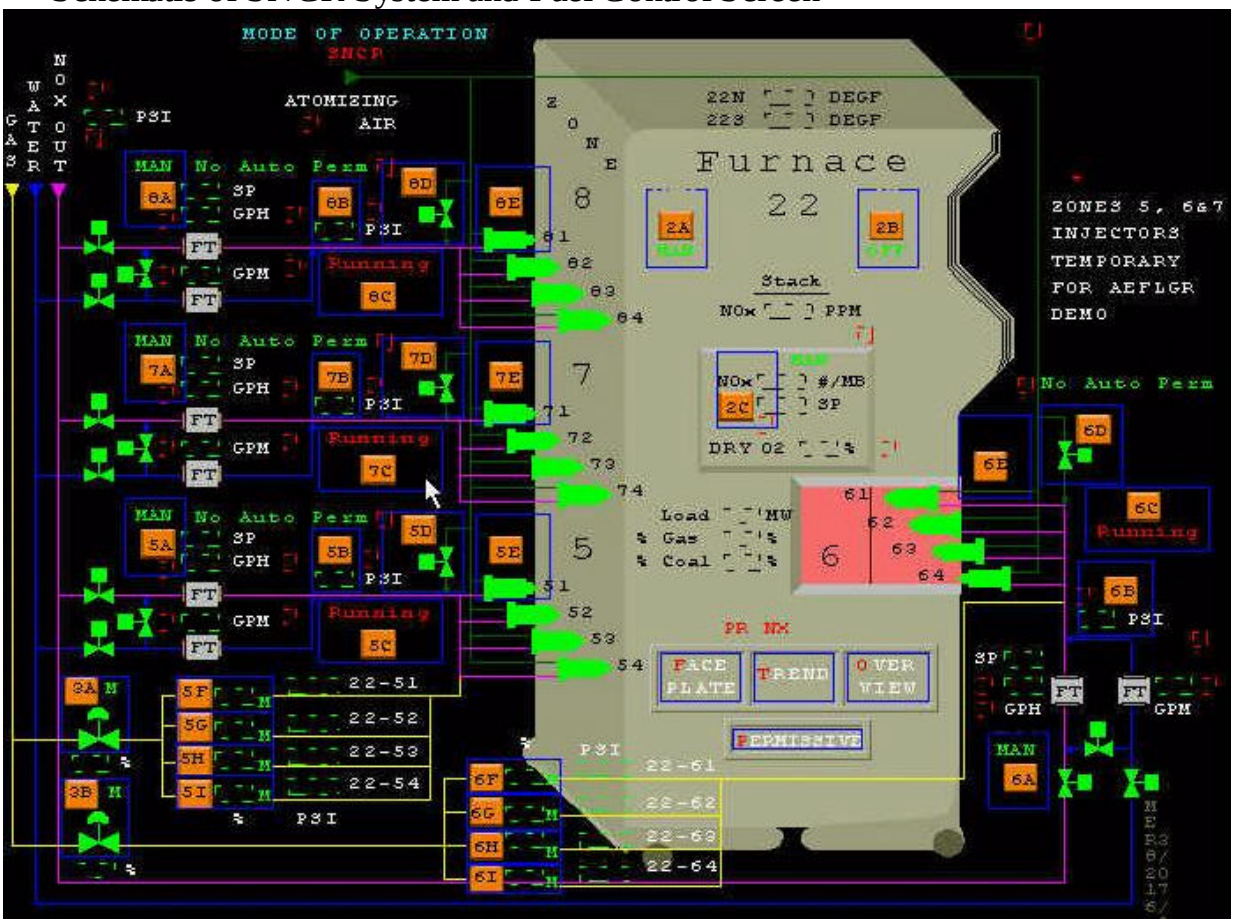
Ammonia-Assisted Fuel-Lean Fuel Reburn Systems

AMMONIA-ASSISTED FUEL-LEAN REBURN

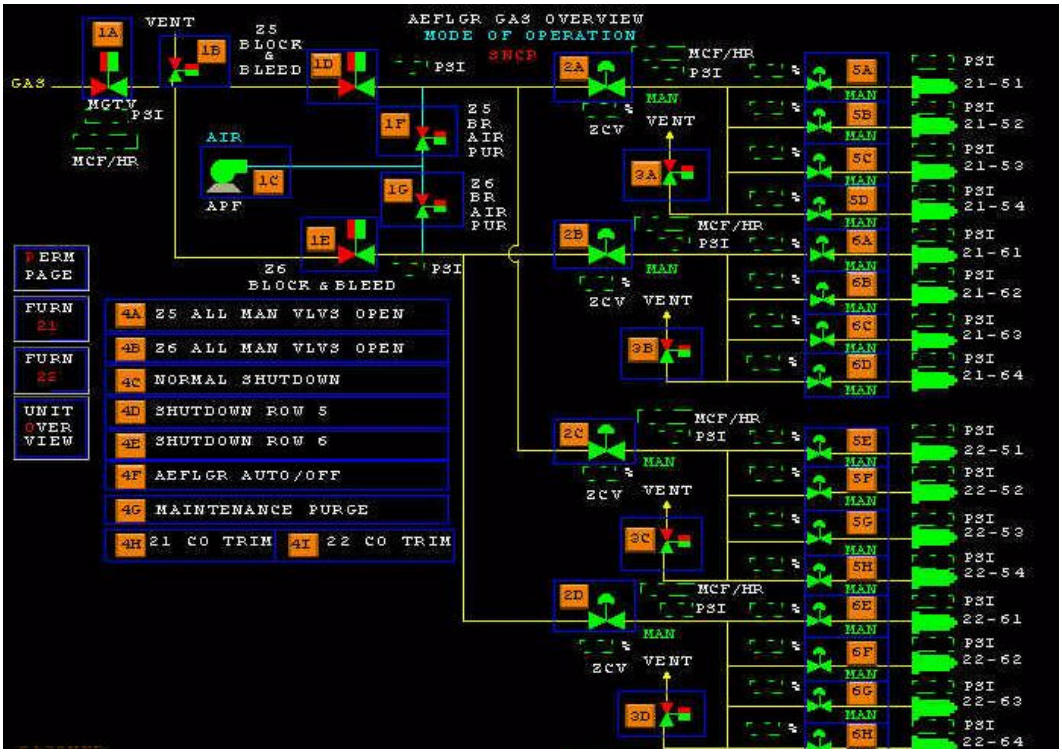
A NO_X control technology called Ammonia-Assisted Fuel-Lean Fuel Reburn (AAFLFR) has been developed by **E**nergy **S**ystems **A**ssociates (**ESA**) and can be provided by **P**hoenix **S**ystems **I**nternational, **I**nc. (**PSII**). The first full scale experiments with this low-cost technology began in January 1998 in the reheat furnace of a 320 MW Foster Wheeler wall-fired, wet bottom boiler at the Public Service Electric & Gas (PSE&G) Mercer Station Unit #2 in Hamilton Township, NJ. Goals of the tests include:

- More than 60% NO_X reduction across all loads
- Less than 10% main fuel input and ammonia injection
- Carbon monoxide (CO) emission level will remain in the satisfactory range.

Schematic of SNCR System and Fuel Control Screen



AMMONIA-ASSISTED FUEL-LEAN REBURN



Fuel control overview screen. All fuel function (start, stop, and emergency trip) controlled from this screen.

Concept of Ammonia-Assisted Fuel-Lean Fuel Reburn (AAFLFR)

The AAFLFR involves injecting a stream of main fuel with ammonia-enhanced injected into the upper furnace flue gas with high-velocity turbulent jets. The process results in chemical reactions to reduce NO_X to molecular nitrogen within the proper temperature window. The amounts and location of natural gas injection are controlled to maintain an overall fuel-lean stoichiometry in the upper furnace, with acceptable CO. This avoids the conventional gas reburning system which is required for completion air (over-fire air) above the gas injection zone. The amount of reagent (urea) injected and locations are controlled to achieve optimum NO_X reduction with acceptable ammonia slip.

Injector auto control and injector retract mechanisms

AMMONIA-ASSISTED FUEL-LEAN REBURN

AAFLFR injector and retract mechanism

Close up of injector control valve with pressure feedback.

Permissive to operate AAFLFG system.

AMMONIA-ASSISTED FUEL-LEAN REBURN

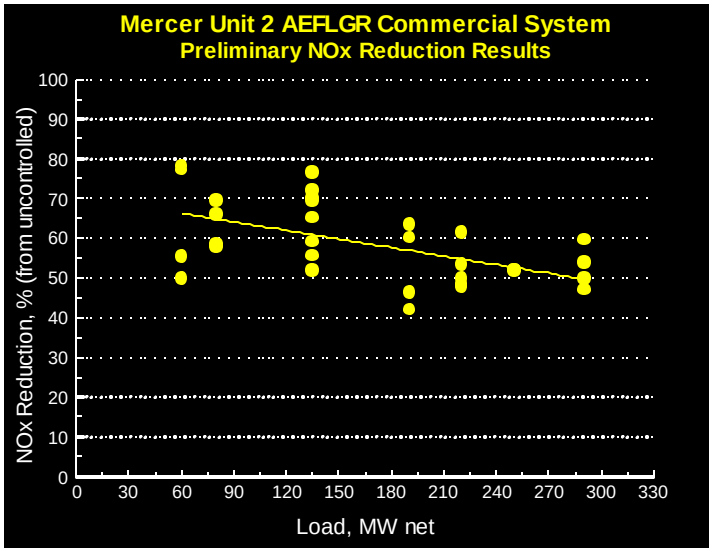
Benefits of Ammonia-Assisted Fuel-Lean Fuel Reburn (AAFLFR)

With installation capital costs, AAFLFR is a highly cost-effective alternative to Selective Catalytic Reduction (SCR) technology for better NO_X control.

The AEFLFR technology offers low capital and control costs that are important to power plant owners who are trying to limit capital investments that may become "stranded assets" in the deregulated environment. These same facilities are also attempting to control or reduce costs of generation to remain competitive when open market access becomes a reality in their service area.

Modifications to the boiler for installation of the AAFLFR systems are limited to small penetrations through the pressurized waterwall that can be made during a regular scheduled outage.

AAFFR System NOx Reduction Results



Chemical reactions of SNCR are highly efficient in reducing NO_X in a narrow temperature window of 1700° to 1900°F. By using the main fuel as a carrier for ammonia, AAFLFR widens the acceptable temperature window, allows ammonia injection at higher temperatures and improves the kinetic rates of the critical chemical reduction mechanisms. Completion of the reactions at higher temperatures also decreases the chance of ammonia slip, an undesirable by-product of the SCR process.

PHOENIX SYSTEMS INTERNATIONAL, INC.

TECH PROFILE
STATE OF THE ART
NASA KENNEDY SPACE CENTER
NOx REDUCTION TECHNOLOGY

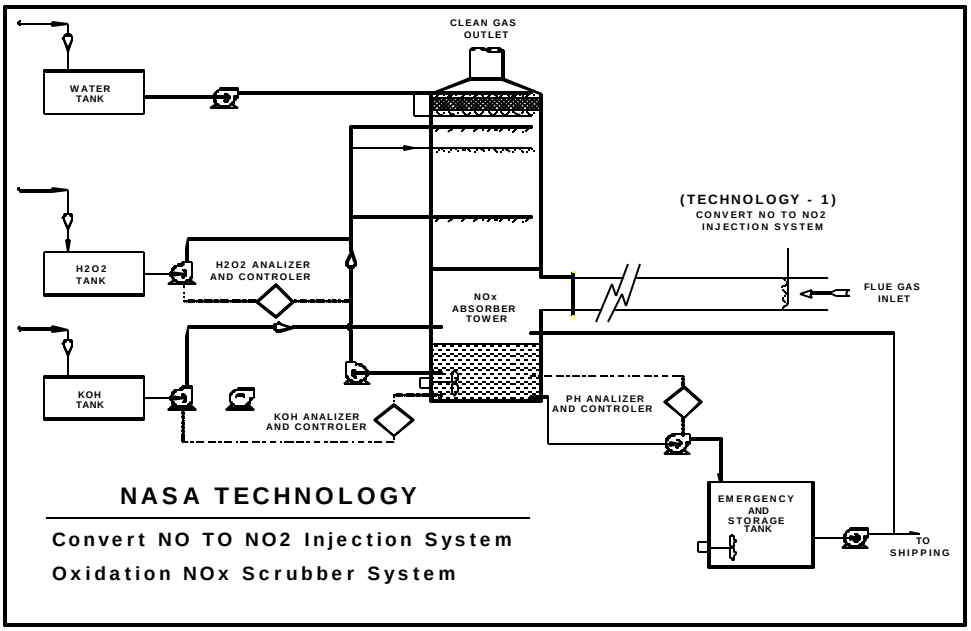
Nitric Oxide (NO) Conversion Technology
and
Oxidation NOx Conversion to Fertilizer Scrubber Technology

PHOENIX SYSTEMS INTERNATIONAL, INC.

NASA Technology

NITRIC OXIDE (NO) CONVERSION TECHNOLOGY AND OXIDATION NO_X CONVERSION TO FERTILIZER SCRUBBER

The National Aeronautics and Space Administration (NASA) has transferred two developed technologies to Phoenix Systems International, Inc. for use in commercial applications. One of the technologies is Nitric Oxide (NO) conversions. The second technology is Conversion of NO_X Scrubber Liquor to Fertilizer. These technologies are innovative systems developed by NASA at the Kennedy Space Center (KSC) to eliminate the waste stream and reduce fuel oxidizer emissions from the nitrogen oxide wet scrubbers used at KSC. The Nitric Oxide (NO) conversion process can achieve the efficiency of 90 - 97%. The Oxidation NO_X Scrubber System and the process can achieve up to 99-percent efficiency in NO_X removal. The chemical process of the wet scrubbers render the oxidizer vapor safe. When the scrubbers mix nitrogen tetroxide or nitrogen dioxide with caustic soda, a liquor of sodium nitrate, sodium nitrite, and nitric oxide is produced. This neutralized liquor could be used as an agricultural fertilizer. An innovative control system has been developed that monitors the concentration of the scrubber liquor. This monitoring system provides a simple, accurate means of continuously monitoring operation of the scrubber. It also provides a means to take process data automatically, unlike manual sampling methods that are commonly used in industry. This system combines known technology with an innovative monitoring process to provide a greatly improved method for control of NO_X emissions.



Potential Commercial Uses

- Specialty chemical producers
- Process control system manufacturers
- Chemical Plant engineering companies
- Metal finishing companies
- Fertilizer producers
- Nitric acid
- Fertilizer
- Dyes
- Adipic acid
- Explosives
- Nitrating reactions
- Metal pickling/finishing operations

Benefits

- Eliminates hazardous waste disposal expenses
- Provides a positive public relations story
- Reduces facility fertilizer expenses
- Could improve scrubbing efficiency (process dependent)
- Provides a simple, accurate monitoring system
- Provides a means for taking process control data automatically
- Produces a useful byproduct while lowering NO_X emissions and eliminating a waste stream
- Cost effective

THE TECHNOLOGY

As we indicated before, the Oxidation NO_X Scrubber System and the process can achieve up to 99% efficiency in NO_X removal. The key feature of this system is its ability to automatically measure the concentration of hydrogen peroxide in the scrubber liquor and its simplicity. The chemical reactions are well-known, but the measuring system, the control unit, and feed pump system make the system process unique. Another unique feature of this NO_X scrubber system is that it does not require a high-temperature environment in order to perform (such as the SCR System, which does require high temperatures).

The process equipment consists of a pH controller and a newly developed hydrogen peroxide concentration controller.

The NASA new emissions control system and process for the oxidizer scrubbers will also have the same effect on the SO_2 in the flue gas stream as to the NOx. The scrubber liquor will react and dissolve the SO_2 and convert to K_2SO_4. The end product K_2SO_4 is also very valuable in use as a fertilizer.

The NASA new emissions control system and process for the oxidizer scrubbers may also have the ability to remove and scrub the heavy metal particle from the flue gas stream. The efficiency and it' s capability for the heavy metal particle scrubbing is on the process to define. The final step to separate/filter the heavy metal particle from the end solution is already available in the industry.

SUMMARY:

Phoenix Systems International, Inc. is very fortunate to acquire this technology from NASA Kennedy Space Center. We are looking forward to sharing this technology with you – **these processes will reduce/eliminate two to three pollution problems in the flue gas stream and convert it to a useful product - fertilizer.**

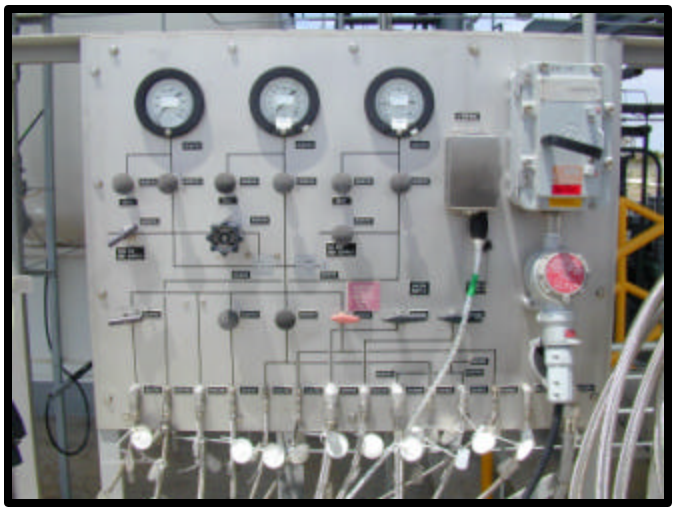
The operating cost for NO_X removal is in the range of US$1,000~US$1,200 per ton, and the end product(KNO_3) for fertilizer use can sell in the price range of US$250~US$350 per ton, which can offset the overall operating costs.

NASA SPACE SHUTTLE LAUNCH PAD

NASA SPACE SHUTTLE LUNCH PAD AND NOx SCRUBBER STATION

NASA NOx SCRUBBER STATION

H2O2 AND PH MONITOR



CONTROL PANEL